Elevance C12 – Low VOC Coalescing Agents

September 13, 2016
Who is Elevance Renewable Sciences?

- High-performing, specialty chemical building blocks from renewable feedstocks
- Novel unsaturated mid-chain esters
- Nobel Prize-winning technology
- US EPA Green Chemistry Challenge Award winner
- Crain’s Chicago Most Innovative Company Top 25 list
- 180,000 MT biorefinery in Gresik, Indonesia
- Additional biorefineries in the engineering phase
- More than 10 high-performance products commercialized in 2015
Elevance Renewable Sciences

Corporate Headquarters, R&D and Pilot Plants
Woodridge, Illinois, USA

Biorefinery
Gresik, Indonesia
Capacity: 180,000 MT
The power of Elevance technology

- Superior performance
- Competitive costs
- Improved environmental and safety footprint
Elevance biorefining process overview

Elevance’s proprietary catalyst and process technology produces unique specialty chemicals with desirable functional attributes previously unavailable in the marketplace.

- **Broad feedstock options**
  - i.e., Palm oil

- **Elevance proprietary catalyst technology**
  - Metathesis

- **Technology proven at scale**

- **Standard chemical unit operations**
  - Transesterification
  - Separations
  - Hydrolysis/Hydrogenation

- **Low capital intensity and low cost of production**

- **High value product mix**
  - Olefins
  - Novel esters
  - Oleochemicals

Novel, advantaged products

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Inherent® renewable building blocks

Unique mid-chain unsaturated esters unlock new performance possibilities

Convert with known ester chemistry

C10 & C12 building blocks methyl esters

Convert with known olefin chemistry

C13 + mixed stream

Difunctional (ester & olefin)  High purity  Unique internal & alpha olefins  Bio-based
Elevance’s C12 Low VOC coalescing agent
How C12-based technology can differentiate coalescing agents

**VOC COMPLIANT**
Our C12 Low VOC product enables VOC profiles of <100 g/l

**IMPROVED EFFICIENCY**
Our C12 coalescing agents are effective at loadings up to 40% less than industry standards

**BETTER FILM PERFORMANCE**
Higher scrub resistance, better block performance, and harder films as a result of reduced loadings and unique molecular structure
Coating material market drivers

**Regulatory**
- Ever-changing and challenging VOC regulations

**Consumers**
- Increasing concerns with chemical odor and emissions
- Desire for higher performing paints
- Demand for more sustainable products

**Performance & Cost**
- Need for higher performing water-based coatings
- Continued push towards lower materials costs

Elevance novel building blocks can be used to unlock better solutions
Coalescing agents in waterborne architectural coatings

- Coalescing agents are solvents that temporary soften the resin particles in water borne coatings allowing the resin particles to coalesce together when the paint dries.
- Without coalescents, latex paints either crack or do not adhere to substrate surfaces upon drying at ambient temperatures.
- High VOC coalescing agents like TMB leave the film allowing the film to harden
- Low coalescing agents typically don’t leave the film, reducing VOC but often sacrificing film properties (lower scrub, poor block, & soft films)

*PCI Magazine, February 2000*
C12 Low VOC – 50% lower VOC, same high performance

- Higher boiling point results in a 50% lower VOC by Method 24.
- Increased efficiency compared to TMB will allow even low VOC profiles.
- Similar to TMB our C12 Low VOC does leave the film allowing similar film hardness to be achieved, with substantially low VOC

<table>
<thead>
<tr>
<th>Properties</th>
<th>C12 Low VOC</th>
<th>TMB</th>
</tr>
</thead>
<tbody>
<tr>
<td>VOC (Method 24), g/g</td>
<td>0.495</td>
<td>1.0</td>
</tr>
<tr>
<td>Boiling point (°C)</td>
<td>268</td>
<td>254</td>
</tr>
<tr>
<td>δ₀ (MPa¹/²)</td>
<td>16.1</td>
<td>15.1</td>
</tr>
<tr>
<td>δᵢ (MPa¹/²)</td>
<td>4.1</td>
<td>6.1</td>
</tr>
<tr>
<td>δₑ (MPa¹/²)</td>
<td>5.3</td>
<td>9.8</td>
</tr>
<tr>
<td>δ/Mpa</td>
<td>17.44</td>
<td>19.01</td>
</tr>
<tr>
<td>Color, PT-CO</td>
<td>&lt;10</td>
<td>&lt;10</td>
</tr>
<tr>
<td>Odor</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
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* 2,2,4 Trimethyl – 1,3 pentanediol mono isobutyrate
C12 Low VOC – solid coalescing performance

Coating performance:
4.5 Deg C low temperature film formation resin:
AC261 (T_g = 29 C, MFFT = 16 C without coalescent)

- Good film formation and scrub performance compared to the TMB, the VOC leader

<table>
<thead>
<tr>
<th>LTFF (40 F)</th>
<th>C12 Low VOC</th>
<th>TMB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coalescent loading</td>
<td>25#/100 gal</td>
<td>25#/100 gal</td>
</tr>
<tr>
<td>% of resin solids</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>10 mil sealed</td>
<td>Pass</td>
<td>Pass</td>
</tr>
<tr>
<td>10 mil unsealed</td>
<td>Pass</td>
<td>Pass</td>
</tr>
<tr>
<td>Scrub cycles</td>
<td>825</td>
<td>850</td>
</tr>
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</table>
C12 Low VOC – higher efficiency compared to TMB

- Elevance’s C12 Low VOC coalescing showed 40% better efficiency compared to TMB
- Up to 40% lower loadings are possible in acryli resins

![Graph showing minimum film formation temperature (MFFT) vs coalescing agent loading (C) for TMB and C12 Low VOC.](image)

*Test methods used: MMFT using TMB and Unify 270 in a Rhoplex SG-30 Acrylic Latex*
C12 Low VOC – good film appearance

Architectural coating – Rhoplex SG-30
Acrylic Latex

- Good gloss, color formation, and contrast ratio
Recap: C12 Low VOC – A better performing Low VOC coalescing agent

- Higher performance, especially in high Tg resins*
  - Increased efficiency (decreased loading requirements)
- Good scrub & block performance
- Low-VOC compliance**
  - Enables 100 g/l or lower VOC
- Formulation flexibility to use other additives as needed
- Bio-degradable
- Bio-based & eco-friendly
- Distinctive odor profile

*Compared to TMB in preliminary coating formulations
**EPA Method 24 preliminary results